CLAIMS

We claim:

1. A sampling chamber for performing optical measurements on a sample of a flowing fluid comprising:

a flow conduit for the passage of the fluid entering and exiting said sampling chamber;

a recessed cavity in fluid contact with said conduit, and disposed in a generally downward direction such that a sample of the fluid in said conduit can enter and exit said cavity so as to repeatedly replace the sample contained therein; and

an optical transmission source for projecting an optical beam into said cavity, along an optical transmission path disposed outside the confines of said conduit.

2. A sampling chamber according to claim 1 and wherein said optical transmission path comprises an entry port for projecting an optical beam from an optical beam source into said cavity though the fluid sample contained therein, and at least one exit port for directing the optical beam from said cavity to at least one exit detector.

3. A sampling chamber according to claim 1 wherein said optical transmission path includes at least one of optic fibers and plastic optical guides.

4. A sampling chamber according to claim 2 and wherein said entry port and said exit port are disposed such that the optical beam traverses said cavity linearly, such that said exit detector measures optical transmission through the fluid sample contained in said cavity.

5. A sampling chamber according to claim 2 and wherein said exit port is disposed at a predetermined angle to the direction of the entering optical beam, such that said exit detector measures optical scattering through the fluid sample contained in said cavity.

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6. A sampling chamber according to claim 2 and wherein said exit port is disposed essentially co-positional with said entry port such that said sampling chamber measures optical back-scattering from the fluid contained in said cavity.

7. A sampling chamber according to claim 1 and wherein said recessed cavity is formed and disposed such that the fluid sample is repeatedly changed by the effects of the flow of the fluid in said conduit.

8. A sampling chamber according to claim 1 and wherein said recessed cavity is formed such that the optical measurements are generally unaffected by flow turbulence in said conduit.

9. A sampling chamber according to claim 1 and wherein said recessed cavity is formed such that the optical measurements are generally unaffected by flow pulsation in said conduit.

10. A sampling chamber according to claim 1, and wherein said conduit is a milk conduit.

11. A sampling chamber according to claim 1, and wherein the optical measurements are utilized to determine a relative concentration of at least one of the components of the fluid.

12. A system for determining a concentration of at least one component of a fluid, the fluid comprising at least two components having different optical properties, said system comprising:

a sampling chamber for performing optical measurements on a sample of a flowing fluid said chamber comprising:

a flow conduit for the passage of the fluid entering and exiting said sampling chamber;

a recessed cavity in fluid contact with said conduit, and disposed in a generally downward direction such that a sample of the fluid in said conduit can enter and exit said cavity so as to repeatedly replace the sample contained therein; and

an optical transmission path projecting an optical beam into said cavity, said optical transmission path disposed outside the confines of said conduit;

a plurality of optical beam sources, at least one of which, when excited, emits an optical beam in an essentially continuum of wavelengths, at least two of said sources having different spectral ranges of emission, said sources being disposed such that the optical beam from said sources is incident to the fluid sample contained in said cavity;

at least one detector selected from the group including

a first detector disposed such that it measures the intensity of said optical beam transmitted through the fluid sample; and

at least one second detector disposed such that it measures the intensity of said optical beam scattered by the fluid sample;

a control system which serially causes excitation of at least two of said optical beam sources, such that the fluid is separately scanned with wavelengths of said optical beams emanating from said at least two optical beam sources; and

a computing system operative to determine the concentration of the at least one component of the fluid from the intensity of at least one of the optical beams transmitted through the fluid and the optical beam scattered by the fluid sample.

13. A system according to claim 12, and wherein said sources are light emitting diodes.

14. A system according to claim 12, and wherein the spectral half width of emission of at least one of said light emitting diodes is less than 40 nanometers.

15. A system according to claim 13, and wherein the spectral half width of emission of at least one of said light emitting diodes is less than 60 nanometers.

16. A system according to claim 12, and wherein said plurality of optical beam sources is at least five sources.

17. A system according to claim 12, and wherein said plurality of optical beam sources is at least ten sources.

18. A system according to claim 12, and wherein said at least one second detector is disposed such that it measures the intensity of the optical beam reflected from the fluid sample.

19. A system according to claim 12 and wherein said computing system is operative to determine the concentration of the component by relating the intensity of said optical beam transmitted through the fluid sample and of said optical beam scattered by the fluid sample to an expression for the concentration in terms of the intensities.

20. A system according to claim 19 and wherein the expression is a polynomial expression of at least second order in the transmitted and scattered intensities.

21. A system according to claim 19 and wherein the transmitted and scattered intensities are related to the concentration of said component by means of empirical coefficients, and wherein said empirical coefficients are determined by a statistical analysis of transmitted and scattered intensities obtained from a plurality of samples of the fluid having known concentrations of said component.

22. The system of claim 20, wherein the statistical analysis is a Partial Least Squares regression method.

23. The system of claim 21, wherein the statistical analysis is a Ridge Least Squares regression method.

24. The system of claim 21 wherein said empirical coefficients are stored in a database, and the concentration is extracted from the transmitted and scattered intensities by means of statistical analysis methods operating on said database.

25. The system of claim 12 wherein said conduit is a milk conduit.

26. The system of claim 25, wherein said system determines the constitution of milk on-line during the milking process.

27. A method of determining the concentrations of at least one component of a fluid, the fluid comprising at least two components having different optical properties, comprising the steps of:

(a) exposing the fluid to at least one incident optical beam from a source essentially having a continuum of wavelengths of emission;

(b) measuring optical transmission and scattering intensities of at least one incident optical beam; and

(c) relating the intensities to a polynomial expression for the concentration of said component in terms of the intensities, the polynomial expression being at least second order in the transmitted and scattered intensities.

28. The method of claim 27, wherein the polynomial expression is of third order in the transmitted and scattered intensities.

29. The method of claim 27, wherein the scattered intensities are back-scattered intensities.

30. The method of claim 27, wherein said source having a continuum of wavelengths is at least one light emitting diode.

31. The method of claim 30, wherein the spectral half width of said at least one light emitting diode is less than 40 nanometers.

32. The method of claim 30, wherein the spectral half width of said at least one light emitting diode is less than 60 nanometers.

33. The method of claim 27, wherein the transmitted and scattered intensities are related to the concentration of said component by means of empirical coefficients, and wherein the empirical coefficients are determined by a statistical analysis of transmitted and scattered intensities obtained from a plurality of samples of the fluid having known concentrations of said component.

34. The method of claim 33, wherein the statistical analysis is a Partial Least Squares regression method.

35. The method of claim 33, wherein the statistical analysis is a Ridge Least Squares regression method.

36. The method according to claim 27, and also comprising the steps of repeating steps (a) and (b) using a plurality of sources, each source having its own continuum of wavelengths.

37. The method of claim 36, wherein at least one of said plurality of sources is a light emitting diode.

38. The method of claim 36, wherein the empirical coefficients are stored in a database, and the concentration is extracted from the transmitted and scattered intensities by means of statistical analysis methods operating on the database.

39. The method of claim 27, wherein exposing the fluid includes exposing milk.